JACC Vol. 8, No. 4
October 1986:930–2

SEMINAR ON COMPUTER APPLICATIONS FOR THE CARDIOLOGIST

Edward A. Geiser, MD, FACC, David J. Skorton, MD, FACC, *Guest Editors*

Introduction

EDWARD A. GEISER, MD, FACC, DAVID J. SKORTON, MD, FACC

Gainesville, Florida and Iowa City, Iowa

During the last several decades there has been a vast increase in the amount of data that physicians are asked to review and retain. A growing body of medical literature has been accompanied by a growing number of diagnostic tests, imaging techniques, drugs and other therapeutic interventions targeted toward particular disease states. With this expansion of knowledge has come a broad expansion in computer technology. Because computers are, essentially, machines capable of storing and handling vast amounts of information in a short period of time, it is logical, that they should be applied in a variety of ways in an effort to help physicians make better use of this burgeoning quantity of information to improve patient care.

Few professionals are involved with computers as extensively as physicians, yet few physicians have had formal in-depth training in mathematics, physics or computer science. Nowhere in medicine is the presence of the computer more pervasive than in the practice of cardiology and cardiovascular surgery. In the hospital, computers are frequently used to store and report laboratory results and demographic information. In the diagnostic imaging laboratory, the evaluation of data from cardiac catheterization studies, echocardiograms and radioisotope scans increasingly depends on specialized computer systems (1). In surgical, medical and cardiac intensive care units, digital technology is employed to monitor vital functions and arrhythmias. In the heart station, computer-assisted interpretation of electrocardiograms is now common (2). In the medical library, computers are widely utilized to search through the literature and provide the physician with particular information from such large collections of information as the National Library of Medicine. In medical education, continuing medical education and patient education, computer-aided instruction, often using such audiovisual aids as laser videodiscs, is becoming an important adjunct to classical teaching methods (3). Most cardiologists are comfortable with computer techniques as long as they are passive elements of the process, and most appreciate how office computer systems can facilitate the business aspects of their practice. However, office computer systems now have vastly increased capabilities (4), and the physician is thus faced with making decisions about investing in computer capabilities in many areas: literature searches and bibliographic management (5), clinical pharmacology and drug interaction searches, assessment of the rationale for therapy and clinical decision making (6), computerized laboratory reports, progress notes and patient medical records (7), computerized history taking from patients, computer-assisted patient education or computerized explanations for informed consent. When placed in this active role of making decisions to purchase computer equipment to perform these tasks, the physician is much less comfortable.

Computer applications committee of ACC. Recognizing the trend toward greater use of computers in cardiology, approximately 2 years ago the American College of Cardiology established a task force on Computer Applications in Cardiology. From this task force, a standing committee of the College developed, the Computer Applications Committee. This committee is charged with evaluating current and likely future uses of computers in the practice of cardiology and cardiovascular surgery and then disseminating this information to the members of the College and other interested parties. To this end, the committee has undertaken a survey of a portion of the College membership and, partly on the basis of the results of this survey, the committee has begun a variety of educational projects dealing with computers in the office practice of cardiology. One of these projects is the seminar that begins in this issue of JACC. In a series of mainly tutorial articles, we will attempt to introduce readers to the broad spectrum of uses to which

From the *Division of Cardiology, Department of Medicine, University of Florida, Gainesville, Florida and the †Cardiovascular Division and Division of General Internal Medicine, Department of Internal Medicine, The University of Iowa, Iowa City, Iowa. This study was supported in part by the American College of Cardiology. Dr. Skorton received Research Career Development Award K04-HL01290 from the National Heart, Lung, and Blood Institute, National Institutes of Health, Bethesda, Maryland.

Address for reprints: Edward A. Geiser, MD, Department of Medicine, Box J-277, JHM Health Center, University of Florida, Gainesville, Florida 32610.

0735-1097/86/$3.50

computers may be put in the office practice of cardiology, covering those topics most likely to be of importance to practitioners of cardiology and related fields. The intent is not only to report on technology, but to place it in the context of improved patient care. Therefore, some of the papers will be brief and oriented toward review of a topic. Others will show examples of specific applications of computing in cardiology, sometimes in the context of a clinical investigation.

Present computer technology. Several trends in the technical aspects of computing promise to make sophisticated computer technology more practical and helpful. For example, advances in semiconductor manufacturing and in the architecture of computers and storage devices will continue to bring the size and price of powerful computing systems within easy reach of most medical practitioners. Consider that much current microprocessor technology is based on the Intel 8088 and 80286 microprocessors. The first of these is a 16-bit microprocessor with an 8-bit data path and the latter is a true 16-bit microprocessor with a 16-bit data pathway. The IBM PC, XT and other competitive computers are based on the 8088 processor. The new IBM AT and its competition are based generally on 80286 microprocessor systems. These newer computers are four to five times faster than their predecessors. Recently, Intel and other manufacturers have announced the development of 32-bit processors, such as the Intel 80386. Although to most cardiologists, this type of technology seems distant from present office use, it has been estimated that by the year 1990 the 32-bit processor will account for $200 million of the microcomputer market and that 84% of its use will be in office automation and personal computers.

Along with the development of increasing capabilities in microprocessors is the development of higher speed, random access memory (RAM). Furthermore, faster and greater capacity hard disks including laser optical storage devices are becoming more accessible. The possibility of laser storage devices to provide gigabytes (10^9 bytes) of storage at a relatively low access time and expense will probably become a reality within the next 1 to 2 years.

Methods of communication over telephone lines are becoming more flexible. As microcomputers continue to proliferate in the medical field and their functions continue to increase, there will probably be greater blurring of distinction between computers and communication devices. Higher speed modems will make communication between remote computers and central data bases more practical for more people. Simultaneously, the ability to address data bases in more standard language, or even by voice, will become a reality.

Present seminar: the office computer systems. The papers constituting this seminar are aimed at bringing these technologic developments in computing into focus for practitioners of cardiovascular medicine and surgery. The present dilemmas of choosing a computer system, and knowing what to expect from an office computer system are covered in the article by Richard B. Shepard, MD and Richard I. Blum, MD. A more detailed report concerning what is on the horizon in computer developments is addressed by Jerome R. Cox, Jr., ScD and Cees Zeelenberg, MS.

Computerized medical record system. Although it is not likely that paper records will disappear within the next few years, the trends in medical practice will be toward storing medical records in computer data bases. With practical telecommunication and office computerized records, data on any patient within a practice can be available to any member of the group who happens to be on call at night or on the weekend. What would it be like to have an office organized in this manner? Is such a system practical or workable? Some insight regarding answers to these questions is provided by one member of a computerized office practice, Michael F. Lesser, MD.

Although computers are capable of storing and integrating massive amounts of information, the "usability" of the information is determined by how the data are entered or, more specifically, by how the storage structure or data base of the computer system is designed. If this is done well, there are many aspects of computerized records that can improve overall patient care. Furthermore, the computer can act as an intermediary between the physician and the patient to improve the quality and completeness of the information in the medical record.

In a sense, the computer can serve to couple the physician's knowledge with that of the patient. When the computer is used to take a history in this manner, the computer's depth of questioning can be related to the seriousness of the medical problem (8). Therefore, detailed elements of the patient's history need not be lost because of physician fatigue or lapse in memory. In a similar manner, laboratory work, and especially the results of special procedures, can be readily available.

One advantage of the computer is random access to data. Instead of paging through charts to collect pertinent historic and laboratory data in a serial (chronologic) fashion, the physician can have these results readily available and sorted by problems. He or she would not have to rely on memory (which may fail) in formulating all the pertinent questions and in recalling all the pertinent data and would not be restricted in decision making by nonavailability of medical test results.

In his article, Michael Lesser, MD discusses the storage requirements of a particular office application. The point is made that the ready accessibility of data is limited by the computer equipment. For this reason, the decrease in cost and tremendous increase in storage capability of modern computer systems are significant. This availability can bring about a marked benefit by providing to those of us with fallible memories complete lists of a patient's problems,

JACC Vol. 8, No. 4
October 1986:930–2

complete historic and laboratory data concerning these problems and complete searches for drug and disease interactions. Furthermore, the patient can feel that all problems have been communicated to the physician.

Telecommunication: medical literature search. As research into so-called high level computer languages and voice-activated systems progresses, the resulting changes are likely to facilitate communication between computers and physicians. Telecommunications technology and software currently being developed promise to improve links among practitioners, between practitioners and hospitals and between practitioners and literature data bases so that access will be simpler and more reliable.

In the not too distant past it was only possible to search the medical literature through the MEDLINE data base of the National Library of Medicine. Several organizations have recently provided interfaces between the user and the data at that library that provide easy to use and easy to learn interfaces for the physician to target information. Within the American College of Cardiology there is also the Griffith Resource Library at Heart House. In their article, Stephen S. Scheidt, MD and two members of the ACC staff at the Griffith Resource Library, Helene Goldstein and Linda Blackburn, discuss the topic of literature searches and how to use them.

Computers in electrocardiography and cardiac imaging. Earlier we alluded to the exposure of the cardiologist to use of the computer for various laboratory tests, especially imaging techniques. L. Thomas Sheffield, MD reviews the involvement of the computer for automated analysis of electrocardiograms, arrhythmia detection, stress testing and other electrophysiologic data. Computer analysis of the electrocardiogram basically grew as digital signal processing techniques developed. Therefore, looking at the role of the computer in state of the art processing and analysis of the electrocardiogram will provide us with a model and a basis for expectations regarding more complex image analysis using computers in the future.

Although the electrocardiogram is essentially a one-dimensional time-varying voltage, an electronic image, as formed using either magnetic resonance or ultrasound, for example, can be thought of as a two-dimensional time-varying voltage. As such, it is somewhat more complex to analyze. The use of digital computers in forming these images and modifying and analyzing them has also led to the common utilization of such imaging techniques as digital subtraction angiography. Steve M. Collins, PhD covers the role that computers have played in the development of state of the art imaging techniques commonly used in cardiology.

Computer-based decision making. As methods for reimbursement to both hospitals and physicians change, cost effectiveness and quality of life become more important issues. It is difficult, at best, for individual physicians to completely review the literature regarding certain diseases and their treatment, integrate that information and arrive at the best, most cost effective strategies for their individual patients. Because of the ability of the computer to store and integrate large amounts of data, the field of decision analysis by computer in patient care is evolving. This field may have a great impact on the practice of medicine and in particular on cardiology. Because this computer application is important yet complex, it seems best illustrated by example. In their contribution, J. Robert Beck, MD and colleagues explore a technique for decision making and follow it through this frequently encountered clinical situation.

Continuing education. Finally, continuing education for the physician, patient education and even patient informed consent are being affected by computer products. Highly realistic situations can be reconstructed using computer technology coupled with devices such as laser videodiscs, as discussed by Abdulla M. Abdulla, MD.

Thus, there are many current benefits to computer applications in cardiology, and the potential for new developments in computer technology promises to simplify many aspects of medical practice. The end point of bringing computers into medicine is to provide improved patient care (9); it is our intent that the reports in this seminar will be helpful in the process of bringing practitioners, computers and the computer industry closer to this goal. We look forward to your comments on the seminar and your suggestions concerning the optimal use of computers in the practice of cardiology.

References

1. Collins SM, Skorton DJ, eds. Cardiac Imaging and Image Processing. New York: McGraw-Hill, 1986.
2. Sridharan MR, Flowers NC. Computerized electrocardiographic analysis. Mod Concepts Cardiovasc Dis 1984;53:37–41.
3. Abdulla AM, Watkins LO, Henke JS. The use of natural language entry and laser videodisk technology in CAI. J Med Educ 1984;59:739–45.
4. Pollak VE. The computer in medicine. Its application to medical practice, quality control, and cost containment. JAMA 1985;253:62–8.
5. Kunin CM. Managing bibliographic citations using microcomputers. Am J Med 1985;78:627–34.
6. Pauker SG, Kassirer JP. The threshold approach to clinical decision making. N Engl J Med 1980;302:1109–17.
7. Barnett GO. The application of computer-based medical-record systems in ambulatory practice. N Engl J Med 1984;310:1643–50.
8. Weed LL, Hertzberg RY. The use and construction of problem-knowledge couplers, the knowledge-coupler editor, knowledge network, and the problem-oriented medical record. Proceedings from the Seventh Annual Symposium on Computer Applications in Medical Care, October 23–26, IEEE, 1983.
9. Miller RA, Schaffner KF, Meisel A. Ethical and legal issues related to the use of computer programs in clinical medicine. Ann Intern Med 1985;102:529–36.